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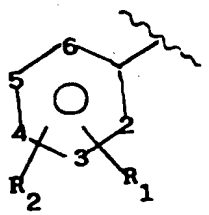
(54) Title: NITRO COMPOUNDS AND THEIR COMPOSITIONS HAVING ANTI-INFLAMMATORY, ANALGESIC AND ANTI-THROMBOTIC ACITIVITIES

(57) Abstract

New compounds and their compositions having anti-inflammatory, analgesic and anti-thrombotic activities, of the general formula: $A\text{-}X_1\text{-}NO_2$ or their salts, wherein: A is $R(COX_u)_t$, wherein t is zero or 1 and u is zero or 1; and X is O, NH or NR_{1C} wherein R_{1C} is C_1-C_{10} alkyl; and R is(Ia) wherein R_1 is acetoxy, preferably in ortho-position with respect to -CO- and R_2 is hydrogen; or derivatives of acetylsalylsalicyclic acid; and X_1 is -YO- wherein Y is C_1-C_{20} alkylene, C_5-C_7 cycloalkylene, oxy-alkyl derivatives and oxy-methyl benzyl derivatives.



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NITRO COMPOUNDS AND THEIR COMPOSITIONS HAVING ANTI-INFLAMMATORY, ANALGESIC AND ANTI-THROMBOTIC ACTIVITIES

The present invention relates to new products having anti-inflammatory, analgesic and anti-thrombotic activities.

In particular it relates to inhibitors of cyclo-oxygenase (COX).

It is known that the anti-inflammatory and anti-thrombotic efficacy, but most of all the tolerance, of NSAIDs (Non Steroid Anti-Inflammatory Drugs), also known as FANS, seem to be considerably affected by their cyclo-oxygenase (COX)-inhibiting activity in the inflammatory site as well as in healthy tissue. See for example FASEB Journal 1, 89, 1987; Bioch. Biophys. Acta 1083, 1, 1991. It is generally believed that the more potent a COX inhibitor is the more effective it is.

The disadvantage of these products is that they are toxic.

Furthermore, it is also known that the COX-inhibiting properties seem to depend on some factors related to the physico-chemical and structural characteristics of the molecules themselves, such as for example the acidic function. See for example J. Pharmacol. Exp. Therap. 196, 226, 1976; Arch. Toxicol. 60, 261, 1987.

The known cyclo-oxygenase inhibitors are generally acids which can be brought back to general structures, including:

- carboxyl acids, either acetylated such as, for example, aspirin and triflusal, or nonacetylated such as, for example, salycilate, diflunisal, salsalate;
- acetic acids, for example diclofenac, indomethacin, tolmetin, sulindac, etodolac, ketorolac;
- propionic acids, such as, for instance, ibuprofen, naproxen, pirprofen, tiaprofenic acid, loxoprofen, indoprofen, oxaprozin, ketoprofen, fenoprofen, fenbufen, flurbiprofen, carprofen, suprofen;
- enolic acids, such as, for example, oxyphenbutazone, phenylbutazone, piroxicam, sudoxicam, tenoxicam, isoxicam, meloxicam.

See patents USP 3,558,690; USP 3,755,427; USP 3,641,127; FR 2,112,111; USP 4,035,376; USP 3,997,669; USP 3,784,701; USP 3,896,145; USP 3,600,437; USP 3,843,681; USP 3,904,682; USP 3,228,831; USP 4,161,538; USP 4,233,299; USP 3,591,584; DE 2,537,070; USP 3,161,654; USP 4,061,779; USP 4,556,672; USP 4,089,969.

The disadvantage of these products is that they are very effective but highly toxic.

The importance of the acidic function lies in the fact that a masking of this function in COX inhibitors results in a virtually complete loss of its prostanoid-inhibiting properties. See Drugs 35, 504, 1988.

Also known are products which are highly effective in inhibiting cyclooxygenase and have a low toxicity even though they do not contain the acidic function in their molecule.

These products are known as nitric esters with nonacidic ending. See for example patents PCT WO 94/04484, which describes a particular group of compounds including the well known commercial product diclofenac; PCT/EP 93/03193, which describes another specific group of compounds including the commercial products flurbiprofen and indoprofen.

The Applicant has unexpectedly found that other compounds having the termination group $-ONO_2$, when X_1 = -YO-, as defined hereinafter, have anti-inflammatory, analgesic and anti-thrombotic activities when used as medicaments with high efficacy in cyclo-oxigenase inhibition and have low toxicity.

A further object of the invention is that the known products as reported in PCT WO 94/04484 and PCT/EP 93/03193 and the new compounds found by the Applicant having X_1 = -YO-

have a pharmaco-dynamic disadvantage. In fact, in the biochemical test evaluating the cyclo-oxygenase-inhibiting activity, experiments conducted by the applicant showed a high response variability, in the order of 10-40%.

This generally results in an erratic and unpredictable efficacy, so that the determination of a correct dosage is difficult.

In practice, higher doses must be administered to limit the above variability. The disadvantage lies in the risks of a higher incidence of side effects.

Another disadvantage is that these products are difficult from a formulation point of view because oral or parenteral preparations are more difficult to prepare than traditional preparations based on acidic FANS.

Molecule solubility is known be one of the most important properties affecting the molecule pharmacokinetic and dynamic processes.

For example, for parenteral administration, particularly by the intravenous route, drugs must be formulated in soluble form.

Similarly, by the oral route, the solubilisation process is decisive for absorption and interaction with the effector.

In this respect, the choice of particular solvents and/or excipients, including surfactants, etc., is also toxicologically critical. For example, an intravenous formulation should not cause haemolysis or incompatibility with blood constituents.

However, there is much evidence which indicates that surfactants and apolar solvents may be irritant. See, for instance, J. Pharm. Science 72, 1014, 1983.

Trials conducted by the applicant using 0.1% Tween 80 and 1% dimethylsulphoxide to suspend nitroxybutylflurbiprofen showed that this solvent was irritant to the gastric mucous membrane.

However, it was unpredictably found that, using a NO-flurbiprofen derivative as described below which is part of the object of the present invention, the amounts of Tween 80 and dimethylsulphoxide required for suspension were lower, such that no irritant effects were caused, even though results were the same in terms of solubilisation.

It was unpredictably and surprisingly found after numerous investigations that it is possible to prepare anti-inflammatory products, as described below, having a high cyclo-oxygenase-inhibiting activity combined with low toxicity and pharmacokinetically satisfactory responses, and

having a very limited response variability with an average variation coefficient of about one half that of known products pharmacodynamically, and easier to formulate as oral or parenteral preparations.

This was totally surprising and unexpected as the factors which affect the anti-inflammatory and anti-thrombotic efficacy of NSAIDs depend on a number of parameters. Therefore, it is not possible to forecast pharmacokinetics, for example the product fraction absorbed, the pharmacodynamic activity, the toxicity and the COX-inhibiting properties and, most of all, no assumptions may be made to predict or limit response variability.

Object of the present invention are compounds, or their compositions, of general formula:

$$A\text{-}X_1\text{-}NO_2$$

or their salts, for use as medicaments, in particular as anti-inflammatory or antithrombotic agents, wherein:

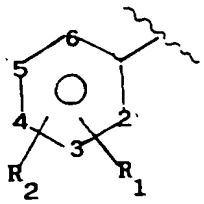
A = $R(COX_u)_t$, wherin t is zero or 1; u is zero or 1,

X = O, NH, NR_{1c} wherein R_{1c} is a linear or branched alkyl having 1 to 10 C atoms;

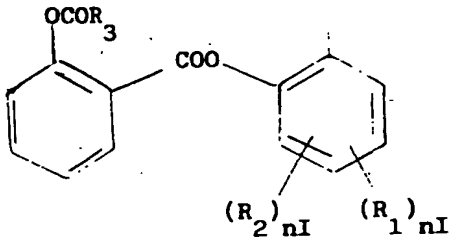
R is chosen from the following groups:

- group I), wherein t = 1 and u = 1

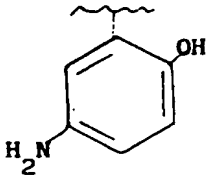
Ia)



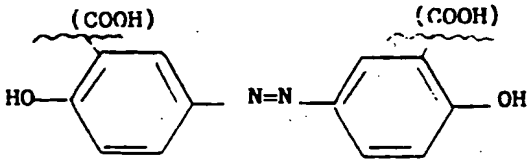
Ib)



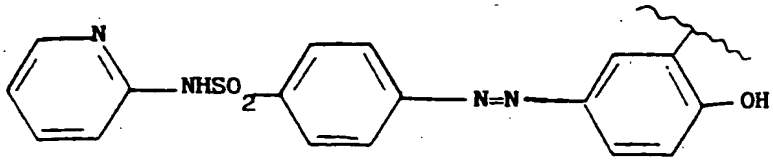
Ic)



Ic$_1$)



Ic$_2$)



Ic$_3$)

wherein:

R_1 is an $OCOR_3$ group, wherein R_3 is methyl, ethyl or a linear or branched C_3-C_5 alkyl, or the residue of a heterocycle with a single ring having 5 or 6 atoms which may be aromatic, partially or totally hydrogenated, containing one or more heteroatoms independently chosen from O, N, and S;

R_2 is hydrogen, hydroxy, halogen, a linear or when permissible branched alkyl having 1 to 4 C atoms, a linear or when permissible branched alkoxyl having 1 to 4 C atoms, a linear or when permissible branched perfluoroalkyl having 1 to 4 C atoms, for example trifluoromethyl, nitro, amino, mono- or di-(C_{1-4})alkylamino;

R_1 and R_2 together are a dioxymethylene group, with the provisos that when X = NH, then X_1 is ethylene and R_2 = H; R_1 cannot be $OCOR_3$ in position 2 when R_3 is methyl; nI being 0 or 1.

Preferably, in Ia) X is equal to O or -NH, R_1 is acetoxy, preferably in ortho-position, with respect to -CO-, X_1 is $(CH_2-CH_2-O)_2$, R_2 is hydrogen, most preferred are the following $A-X_1-NO_2$ compounds: 3-acetoxy-N-(2-nitroxyethyl)-benzamide, 4-acetoxy-N-(2-nitroxyethyl)-benzamide, 3-acetoxy-N-(5-nitroxypentyl)-benzamide; 2-acetoxy-n-(5-nitroxypentyl)benzamide, N-2-(nitroxyethyl)-2-propionoxy-benzamide, 2-acetoxy-

2-nitroxy-ethyl benzoate, 2-acetoxy-N-(cis-2-nitroxycyclohexyl)-benzamide, 2-acetoxy-4-chloro-N-(2-nitroxyethyl)-benzamide, N-(2-nitroxyethyl)-2-((4-thiazolyldinyl)carbonyloxy)-benzamide hydro chloride, 2-nicotinoyloxy-N-(2-nitroxyethyl)-benzamide, 2-acetoxy-5-nitroxypentylbenzoate;

preferably, in Ib) $R_3 = CH_3$, nI = 0;

X is equal to O, X_1 is ethylene: in this case Ib) is the residue of acetylsalicylsalicylic acid;

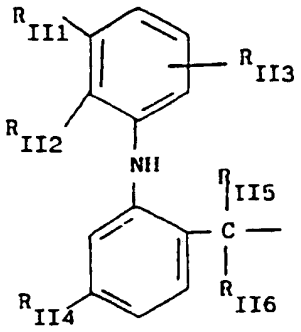
Compounds Ic) of the class Ic_1) 5-amino salicylic acid derivatives (5-amino-2-hydroxybenzoic acid) are known as mesalamine when the valence is saturated with -COOH.

In compounds Ic_2) at least one of the -COOH is reacted to form the compounds of the invention. When both -COOH are reacted one obtains bifunctional compounds. When the compound is saturated with -COOH, is known as olsalazine.

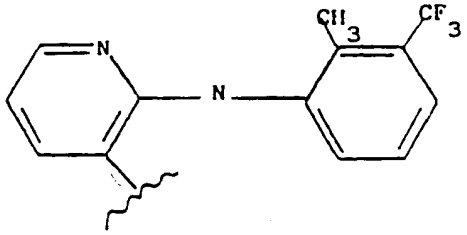
Compounds Ic_3) are known, when the starting radical has a -COOH as sulfasalazine: 2-hydroxy-5-[(4-[(2-pyridinylamino)sulphonyl]phenyl]azo]benzoic acid.

The preferred compounds of Ic) have X = O and u = 1 and X_1 is different from -YO-.

- group II) wherein t = 1, u = 1



IIa)



IIb)

wherein:

R_{II5} is H, a linear or branched C_1-C_3 alkyl when permissible R_{II6} has the same meaning as R_{II5}, or, when R_{II5} is H, it may be benzyl;

R_{III}, R_{II2} and R_{III3} independently from one another are hydrogen, a linear or when permissible branched C_1-C_6 alkyl, or C_1-C_6 alkoxy, or Cl, F, Br;

R_{II4} is R_{III} or bromine;

preferred are the compounds wherein R_{III}, R_{II2} and R_{II4} are H and R_{III3} is chlorine and R_{III3} is in the ortho position rela-

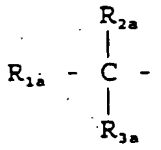
tive to NH;

R_{IIs} and R_{II6} are H, X is equal to O, and X_1 is $(CH_2-CH_2-O)_2$;

IIb) is the residue of 2-[(2-methyl-3-(trifluoromethyl) phenyl]amino]-3-pyridinecarboxylic acid] and when -COOH is present is known as flunixin.

Preferred compounds are those in which u = 1 and X = O.

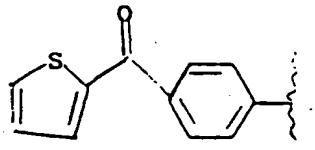
- group III), wherein t = 1, u = 1 and R is:



wherein:

R_{2a} and R_{3a} are H, a linear or when permissible branched, substituted or non-substituted C_1-C_{12} alkyl, allyl, with the proviso that when one of the two groups is allyl, the other is H; preferably R_{2a} is H, an alkyl having from 1 to 4 C, R_{3a} is H;

R_{1a} is chosen from



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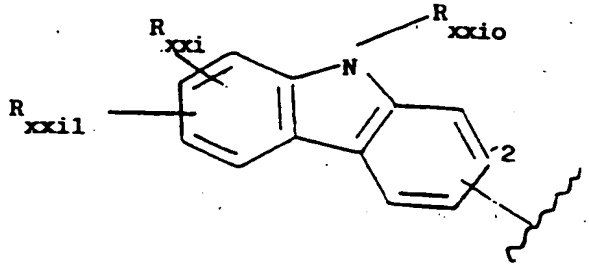

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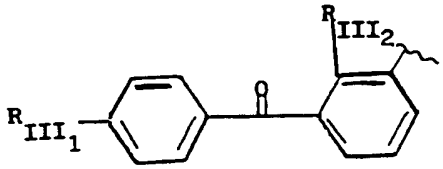

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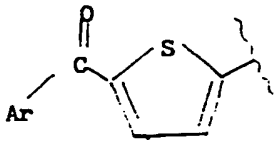

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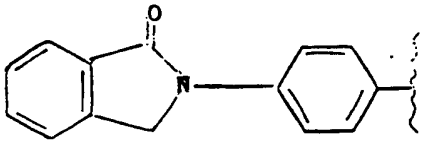

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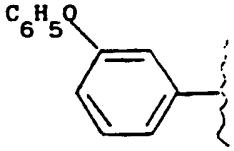

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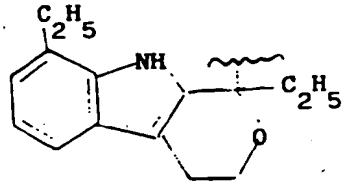

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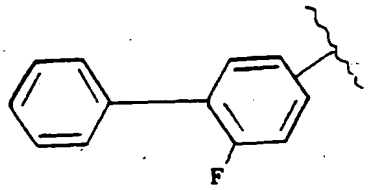

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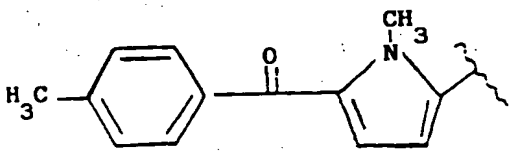

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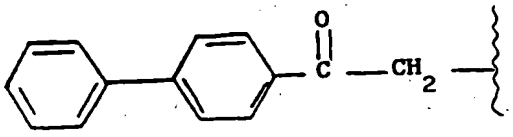
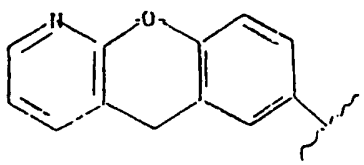
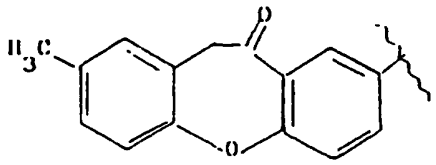


(III)

III D) has the following compounds:



IIIa)



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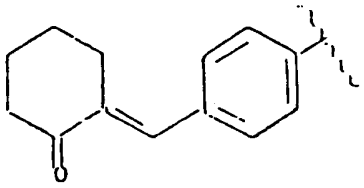

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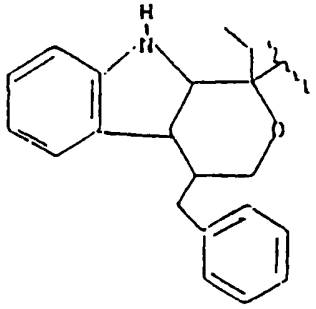

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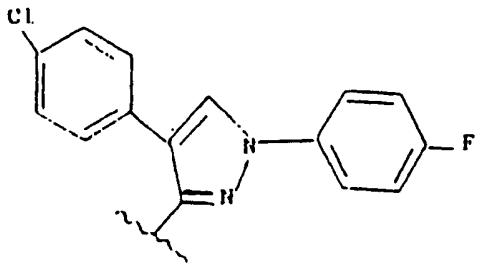

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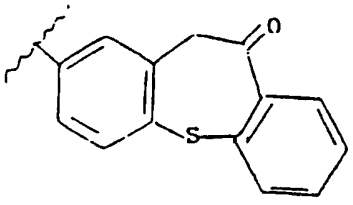

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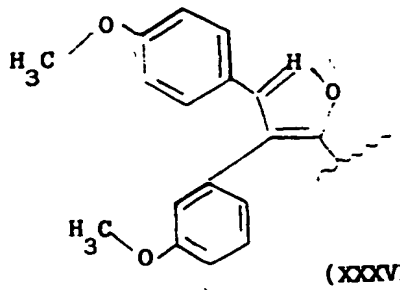


(XXXVII)

wherein the meanings are as follows:

- in the compound of formula (IV), residue of Ketoprofen:

  R_{III1} is H, SR_{III3} wherein R_{III3} contains from 1 to 4 C atoms, linear or when permissible branched;

  R_{III2} is H, hydroxy;

  preferred are the compounds wherein R_{III1} and R_{III2} are H, R_{1a} is H and R_{2a} is methyl, X = O;

- in the compounds of formula (XXI), residue of carprofen:

  R_{XXio} is H, a linear or when permissible branched alkyl having from 1 to 6 C atoms, a C_1-C_6 alkoxycarbonyl bound to a C_1-C_6 alkyl, a C_1-C_6carboxylalkyl, a C_1-C_6 alkanoyl, optionally substituted with halogens, benzyl or halobenzyl, benzoyl or halobenzoyl;

  R_{XXi} is H, halogen, hydroxy, CN, a C_1-C_6 alkyl optionally containing OH groups, a C_1-C_6 alkoxy, acetyl, benzyloxy, SR_{XXi2} wherein R_{XXi2} is an alkyl C_1-C_6; a perfluoroalkyl having from 1 to 3 C atoms, a C_1-C_6 carboxyalkyl

optionally containing OH groups, NO_2, ammino, sulphamoyl, a dialkyl sulphamoyl with the alkyl having from 1 to 6 C atoms, or a difluoroalkylsulphonyl with the alkyl having from 1 to 3 C atoms;

R_{xxi1} is halogen, CN, a C_1-C_6 alkyl containing one or more OH groups, a C_1-C_6 alkoxy, acetyl, acetamide, benzyloxy, SR_{III3} as above defined, a perfluoroalkyl having from 1 to 3 C, hydroxy, a carboxyalkyl having from 1 to 6 C, NO_2, ammino, a mono- or di-alkylamino having from 1 to 6 C, sulphamoyl, a di-alkyl sulphamoyl having from 1 to 6 C, or a difluoroalkylsulphamoyl as above defined; or R_{xxi} together with R_{xxi1} is an alkylene dioxy having from 1 to 6 C;

preferred are the compounds wherein R_{xxio} is H, the connecting bridge is in position 2, R_{xxi} is H, R_{xxi1} is chlorine and is in the para position relative to nitrogen;

R_{3a} is H, R_{2a} is methyl and X is O;

- in the compounds of formula (XXXV), residue of tiaprofenic acid:

Ar is phenyl, a hydroxyphenyl optionally mono- or polysubstituted with halogen, an alkanoyl and an alkoxy having from 1 to 6 C, a trialalkyl having from 1 to 6 C, preferably from 1 to 3 C, cyclo-pentyl, cylo-hexyl,

cyclo-heptyl, heteroaryl, preferably thienyl, a furyl optionally containing OH, pyridyl;

the preferred (XXXV) compounds are those wherein Ar is phenyl, R_{3a} is H, R_{2a} is methyl and X is O;

- in the compound of formula (II), residue of suprofen, of which the one preferred has been shown, wherein R_{3a} is H, R_{2a} is methyl and X = O; its equivalents as described and obtained in USP 4,035,376, which is incorporated herein in full as a reference, may also be used;
- in the compound of formula (VI), of which the ones preferred indoprofen, when R_{2a} is CH_3 and indobufen when R_{2a} is equal to H, R_{3a} = $-CH_3$ and X = O have been shown;

its equivalents as described in and obtained in accordance with USP 3,997,669, which is incorporated herein in full as reference, may also be used;

- in the compounds of formula (VIII), of which the one preferred, etodolac, wherein R_{2a} = R_{3a} = H and X = O has been shown; its equivalents as described in and obtained in accordance with USP 3,843,681, which is incorporated herein in full as reference, may also be used;

- in the compounds of formula (VII),

  of which the one preferred, fenoprofen, wherein R_{3a} = X, R_{2a} = $-CH_3$ and X = O has been shown; its equivalents as described in and obtained in accordance with USP 3,600,437, which is incorporated herein in full as reference, may also be used;

- in the compounds of formula (III),

  of which the preferred, fenbufen, wherein R_{2a} = R_{3a} = H and X = O has been shown; its equivalents as described in and obtained in accordance with patent USP 3,784,701, which is incorporated herein in full as a reference, may also be used;

- in the compounds of formula (IX), residue of flurbiprofen wherein R_{3a} is H, R_{2a} is $-CH_3$ and X = O;

- in the compounds of formula (X), residue of tolmetin, wherein R_{2a} = R_{3a} = H and X = O;

  its equivalents as described in and obtained in accordance with patent FR 1,574,570, which is incorporated herein in full as a reference, may also be used;

In class III D) the meaning is the following:

- IIIa) when it contains the $-CH(CH_3)-COOH$ is known as pranoprofen: α-methyl-5H-[1]benzopyrano [2,3-b]pyridine-7-acetic acid.

In the preferred compound R_{2a} = H, R_{3a} = CH_3, u = 1 and X = O.

- The residue (XXX) when contains -$CH(CH_3)$-COOH is known as bermoprofen: dibenz[b, f]oxepin-2-acetic acid.

The preferred compound has u = 1, X = O, R_{2a} = H, R_{3a} = CH_3.

- The residue of (XXXI) is known as CS-670: 2-[4-(2-oxo-1-cyclohexylidenemethyl)phenyl]propionic acid, when the radical is -$CH(CH_3)$-COOH.

The preferred compound has R_{2a} = H, R_{3a} = CH_3, u = 1, X = O.

- The residue (XXXII) derives from the known pemedolac which contains the -CH_2COOH groups.

The preferred compound has R_{2a} = R_{3a} = H, u = 1 and X = O.

- This residue (XXXIII) is known as pirazolac when is saturated with -CH_2COOH:

4-(4-chlorphenyl)-1-(4-fluorphenyl)3-pyrazolyl acid derivatives.

Preferred compounds have R_{2a} = R_{3a} = H, u = 1 and X = O.

- The residue (XXXVI) when saturated with -$CH(CH_3)$-COO-, is known as zaltoprofen.

When the residue is saturated with an hydroxy or an amino group or the salts of the acid, the compounds are known as dibenzothiepin derivatives.

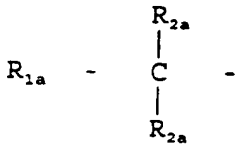
The preferred products have a R_{2a} = H, R_{3a} = CH_3, u = 1,

X = O.

The residue (XXXVII) is deriving from the known mofezolac: 3,4-di(p-methoxyphenyl)isoxazol-5-acetic acid when the residue is $-CH_2-COOH$.

Preferred compounds R_{2a} = R_{3a} = H, t = 1, X = O.

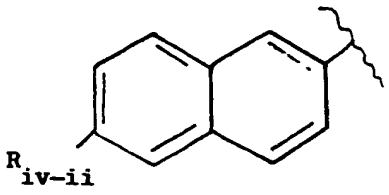
group IV) in which t = 1, u = 1 and R is



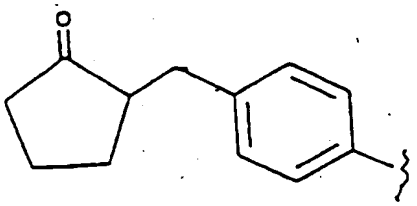
wherein:

R_{IVd} and R_{IVd1} are at least one H and the other a linear or when permissible branched C_1-C_6 alkyl, preferably C_1 and C_2, or a difluoroalkyl with the alkyl having from 1 to 6 C, C_1 is preferred, or R_{IVd} and R_{IVd1} together form a methylene group;

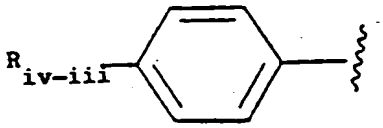
R_{IV} has the following meaning:



(II)



(X)



(III)

wherein the compounds of group IV) have the following meanings:

- in the compounds of formula (II):

  R_{iv-ii} is a 1-6 C alkyl, a cycloalkyl having from 3 to 7 C, an alkoxymethyl having from 1 to 7 C, a trifluoroalkyl having from 1 to 3 C, vinyl, ethinyl, halogen, an alkoxy having from 1 to 6 C, a difluoroalkoxy with the alkyl having from 1 to 7 C, an alkoxymethyloxy having from 1 to 7 C, an alkylthiomethyloxy with the alkyl having from 1 to 7 C, an alkyl methylthio with the alkyl having from 1 to 7 C, cyano, difluoromethylthio, phenyl-or phenylalkyl substituted with the alkyl ha-

ving from 1 to 8 C;

preferably R_{iv-ii} is $-CH_3O$, R_{IVd} is H and R_{IVd1} is $-CH_3$, and is known as a residue of naproxen;

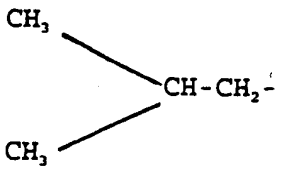
X = NH and X_1 is equal to $-(CH_2-CH_2-O)_2$; also preferred is the same compound wherein X is equal to O;

- in the compounds of formula (X),

of which the residue of loxoprofen has been shown, the residues described in USP 4,161,538, which is incorporated herein in full as a reference, may be used as equivalents. Preferred are the compounds in which R_{IVd} is H and R_{IVd1} is $-CH_3$, X = NH and X_1 is equal to $(CH_2-CH_2-O)_2$; also preferred is the same compound wherein X is equal to O;

- in the compounds of formula (III):

R_{iv-iii} is a C_2-C_5 alkyl, even branched whenever possible, a C_2 and C_3 alkyloxy, allyloxy, phenoxy, phenylthio, a cycloalkyl having from 5 to 7 C atoms, optionally substituted in position 1 by a C_1-C_2 alkyl; preferred is the compound wherein R_{iv-iii} is

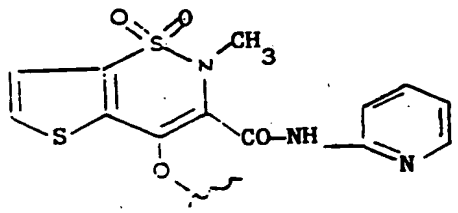


and R_{IVd} = H, R_{IVd1} is $-CH_3$, a compound known as a residue

of ibuprofen;

X = NH and X_1 is equal to $(CH_2-CH_2-O)_2$; also preferred is the same compound wherein X is equal to O;

- group V)



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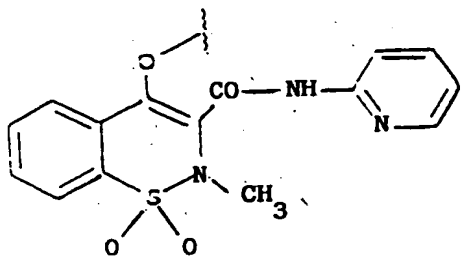

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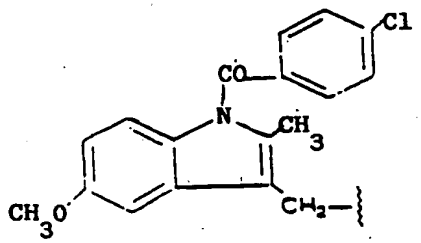

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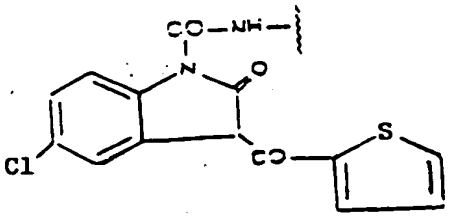
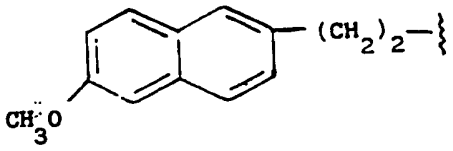
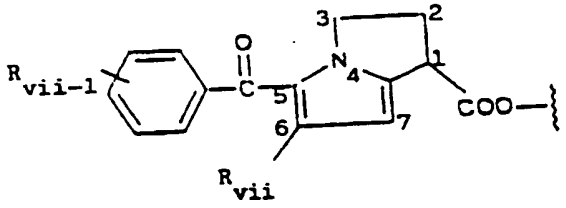


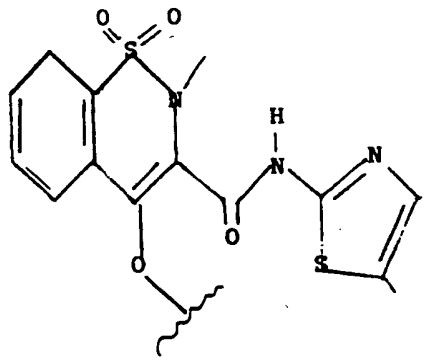


(III)

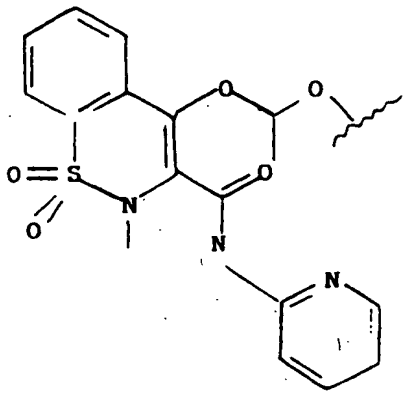


(II)

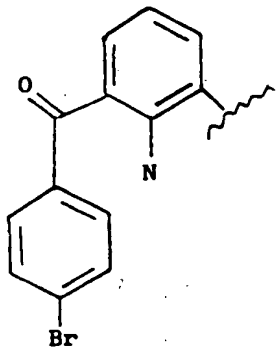
Class VE)



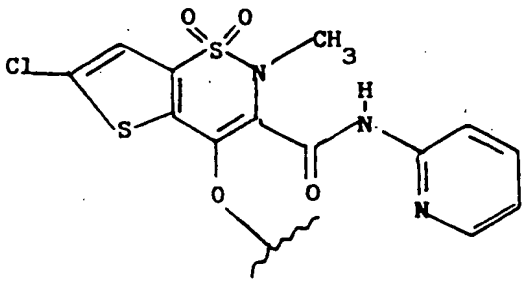
(X)



(XI)



(XII)



(XIII)

In group V), the compounds have the following meanings:

- in the compounds of formula (II)

  R_{vii} is H or a linear or when permissible branched alkyl having from 1 to 4 C;

  R_{vii-1} is R_{vii} or a linear or when permissible branched alkoxy having from 1 to 4 C; Cl, F, Br; the position of R_{vii-1} being o-,m- or p-;

  preferred is the residue of the known ketorolac, wherein R_{vii} and R_{vii-1} are H, and A = R and t = 0

- in the compounds of formula (V),

  of which the residue of the known tenidap has been shown, its equivalents as described and obtained in USP 4,556,672, which is incorporated herein in full as a reference, may also be used;

  in these compounds of formula (V) A = R and t = 0,

- in the compounds of formula (VII)

  of which the residue of the known tenoxicam has been shown, A is RCO and t = 1 and u = 0 or A is R and t = 0; its equivalents as described and obtained in patent DE 2,537,070, which is incorporated herein in full as a reference, may also be used;

- in the compounds of formula (IX)

  where A = R and t = 0, or A = RCO with t = 1 and u = 0,

of which the residue of the known piroxicam has been shown, its equivalents as described and obtained in USP 3,591,584, which is incorporated herein in full as a reference, may also be used;

- in the compounds of formula (III)

where A = RCOO, t = 1 and u = 0 or 1; or t = 0 and A = R, of which the residue of the known nabumetone has been shown, its equivalents as described and obtained in USP 4,061,779, which is incorporated herein in full as reference, may also be used;

- in the compounds of formula (IV)

where A = RCOO, t = 1, u = 1 of which the residue of the known indomethacin has been shown, its equivalents as described and obtained in USP 3,161,654, which is incorporated herein in full as reference, may also be used.

- in compounds of formula (X):

the residue (X) is known as meloxicam.

Preferred compounds are those in which t = 0.

- The residue (XI) is known as ampiroxicam when the termination is $-COOC_2H_5$.

The preferred compounds have u = 1 and X = O; or t = 0.

- The residue (XII) when is saturated with $-CH_2COO-$ is

known as bromfenac.

The preferred compounds have u = 1, X = O and R_{2a} = R_3a = H; or t = 0.

- The residue XIII) derives from the known Lornoxicam when the valence is saturated with H.

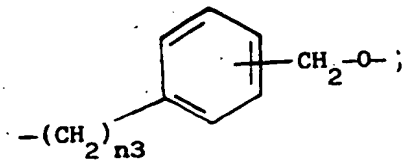
Preferred compounds have t = 0.

X_1 in the formula A-X_1-NO_2 is a bivalent connecting bridge chosen from the following:

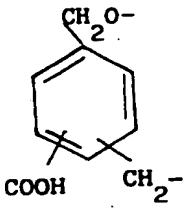
-YO-

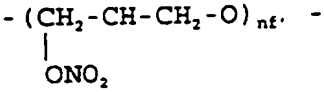
where Y is:

- a linear or when permissible branched C_1-C_{20} alkylene, preferably having from 2 to 5 carbon atoms, excluding this connecting bridge when R is:
  - a radical of group I) except class Ib) and Ic);
  - a radical of group II) except II_b);
  - a radical of group III) except class of compounds of IIID)
  - a radical of group IV);
  - a radical of group V), except X) and including -$(CH_2)_4$- for the compounds of formulae (III) and (IV);
- or a cycloalkylene having from 5 to 7 carbon atoms optionally substituted;

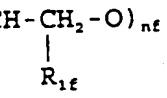


wherein n_3 is 0 or an integer from 1 to 3





wherein nf' is an integer from 1 to 6, preferably from 1 to 3;



wherein R_{1f} = H, $-CH_3$ and nf is an integer from 1 to 6, preferably from 2 to 4.

The compounds containing R of group I of type Ia) are described in patent WO92/01668 wherein the preparation methods are also described. This patent is incorporated herein in full as a reference. The compounds of type Ib) are prepared, for instance, using the method described in the Merck

Index, XI Ed., 1989, page 16, n.95, for the residue of acetylsalicylsalicylic acid. The changes in the compounds of formula Ib) may be obtained applying the processes described in patent WO 92/01668.

Compounds Ic) of the class Ic_1), in which the radical is a 5-amino salicylic acid derivative (5-amino-2-hydroxybenzoic acid) known as mesalamine, when the starting radical contains -COOH, are prepared by reduction of m-nitrobenzoic acid with Zn dust and HCl (see H. Weil et al., Ber. 55B, 2664 (1922)); or by electrolitic reduction: Le Guyader, Peltier, Compt. Rend. 253, 2544 (1961). These publications are incorporated here by reference.

The starting radical Ic_2) when it contains -COOH is known as olsalazine: 3,3'-azobis(6-hydroxybenzoic acid); and it is prepared according to EP 36,636 or USP 4,528,367, here both incorporated by reference.

Compounds Ic_3) are prepared according to USP 2,396,145 here incorporated by reference.

Equivalent compounds to Ic_1), Ic_2) and Ic_3) contain the substituents indicated in the above references.

The products of the present invention having the general formula

$$A\text{-}X_1\text{-}NO_2$$

with the connecting bridges X_1 as above defined, with respect to the compounds of group I), may be obtained using the above methods of the known art or changing the known methods by introducing bridges X_1 when these are different from the connecting bridges described in the above patents.

The compounds wherein R is of group II) are described in patents WO94/04484 and USP 3,558,690 wherein the preparation methods are also described. These patents are incorporated herein in full as a reference.

The starting compound of IIb), when the valence is saturated with -COOH (flunixin), is obtained according to USP 3,337,570 and USP 3,689,653 here incorporated by reference. Compounds containing the substituents indicated in the above patents are equivalent to flunixin.

With respect to the compounds of group II), the connective bridges X_1 as above defined may be obtained using the above methods of the known art or changing the known methods by introducing bridges X_1 when these are different from the connecting bridges described in the above patents.

The compounds wherein R is of group III) are described and obtained by the processes explained in the following patents: patent application PCT/EP/93 03193; for the compounds of formula (IV) also see USP 3,641,127; for the com-

pounds of formula (XXI) also see USP 3,896,145; for the compounds of formula (IX), residue of flurbiprofen, also see USP 3,755,427; for the compounds of formula (II) also see USP 4,035,376; for the compounds of formula (VI) also see USP 3,997,669; for the compounds of formula (VIII) also see USP 3,843,681; for the compounds of formula (VII) also see USP 3,600,437; for the compounds of formula (III) also see USP 3,784,701. All these patents are incorporated herein in full as a reference.

The processes for the preparation of compounds of class III D) are the following:

IIIa) residue is obtained by preparing the acid compound, according to USP 3,931,205, the valence is saturated with $-CH(CH_3)-COOH$. Compounds containing the substituents indicated in the above patent are equivalent to pranoprofen.

The residue (XXX) is prepared through the compound with $-CH(CH_3)-COOH$ (bermoprofen) according to USP 4,238,620 here incorporated by reference.

Other equivalent products are listed in the above patent.

The residue (XXXI) is prepared by starting from the corresponding acid $-CH(CH_3)-COOH$, according to USP 4,254,274. Equivalent compounds are listed in that patent.

The residue (XXXII) is prepared according to EP 238226

here incorporated by reference when the valence is saturated with $-CH_2COOH$. Equivalent products are reported in said patent as substituted 1,3,4,9 tetrahydropyrane [3,4-b] indole-1-acetic acids.

The residue (XXXIII) is prepared by pirazolac (the valence is saturated with $-CH_2COOH$), as indicated in EP 54,812 here incorporated by reference. Equivalent products are listed in the said patent.

The residue (XXXVI) is prepared according to the patent UK 2,035,311 here incorporated by reference, by starting from zaltoprofen having termination $-CH(CH_3)-COO-$. Equivalent products are listed in the said patent.

The process of preparation of the residue XXXVII) is obtained by starting from the Mofezolac and it is prepared according to EP 26928. Equivalent products are reported therein.

With respect to the compounds of group III), the connecting bridges X_1 as above defined may be obtained using the above methods of the known art or changing the known methods by introducing bridges X_1 when these are different from the connecting bridges described in the above patents.

The compounds wherein R is of group IV) are described in the English patent application 9320599.5 wherein the pre-

paration methods are also described. This patent is incorporated herein in full as a reference.

In group IV) the compounds may also be obtained: for the compounds of formula (II), using patent USP 3,904,682; for the compounds of formula (X), in accordance with patent USP 4,161,538; for the compunds of formula (III), in accordance with patent USP 3,228,831. These patents are fully included in the present application as a reference.

With respect to the compounds of group IV), the connecting bridges X_1 as above defined may be obtained using the above methods of the known art or changing the known methods by introducing bridges X_1 when these are different from the connecting bridges described in the above patents.

The compounds wherein R is of group V) are described in the Italian patent MI94A 000916 wherein the methods of preparation are also described. This patent is incorporated herein in full as a reference. In group V) the compounds may also be obtained: for the compounds of formula (II), using patent USP 4,089,969 which is incorporated herein in full as a reference; for the compounds of formula (V) may be obtained in accordance with patent USP 4,556,672 which is incorporated herein in full as a reference.

The residue (X) is prepared according to German patent

2,756,113. Equivalent products are listed in the said patent.

The residue (XI) is prepared according to the patent EP 147,177 here incorporated by reference, by starting from ampiroxicam having the termination $-COOC_2H_5$. Equivalent products are listed in the said patent.

The residue (XII) is prepared according to J. Medicinal Chem., vol. 27, No. 11, Nov. 1984, Walsh et al, Antiinflammatory Agents. 3. Synthesis and Pharmacological Evaluation of 2-Amino-3-Benzoylphenylacetic Acid and Analogues, here incorporated by reference. Equivalent products are listed in said publication.

The residue (XIII) is prepared by starting by the Lornoxicam, wherein the valence is saturated with H. It is prepared according to GBP 2,003,877. Equivalent products are described in said patent.

With respect to the compounds of group V), the connecting bridges X_1 as above defined may be obtained using the above methods of the known art or changing the known methods by introducing bridges, X_1 when these are different from the connecting bridges described in the above patents.

Generally, the connection between A and X_1 is, as we saw, generally, of the ester or amide type (NH or NR_{1c}, as

defined in X) when R is of groups I), II), III), IV). All well known synthetic routes for forming these bonds may be used to form this connection.

In the case of esters of group I), III) and IV), the most direct synthetic route involves a reaction of acyl chlorides R-CO-Cl with halogen alcohols of the HO-Y-Cl, HO-Y-Br, HO-Y-I types, in the experimental conditions of the known art.

The reaction products of formula R-CO-O-Y-Cl(Br,I) may also be obtained for class II by reacting the sodium or potassium salts of said R-CO-OH acids with dihalogen derivatives of the general formula YCl_2, YBr_2 or YI_2.

The reaction products are converted into the final products by reacting with $AgNO_3$ in acetonitrile, in accordance with literature reports.

The general route for groups I), III), IV) is as follows:

R-CO-Cl + HO -Y- Br -----> R-CO-O-Y-Br + $AgNO_3$ ----->

$A-X_1-NO_2$ wherein X_1 = YO.

The general route for group II is as follows:

R-CO-ONa + Br_2Y ------> R-CO-O-Y-Br + $AgNO_3$ -----> $A-X_1-NO_2$ wherein X_1 = YO.

In the case of amides the synthetic route involves a

reaction of the same acyl chlorides RCOCl with amino alcohols of the general formula NH_2-Y-OH, NHR_{1c}-Y-OH to give amides of the general formula:

R-CO-NH-Y-OH and R-CO-NR_{1c}-Y-OH

in accordance with known methods.

The reaction of said amides with halogenating agents such as, for example, PCl_5, PBr_3, $SOCl_2$, etc., leads to halogen derivatives of the general formula:

R-CO-NH-Y-Br(Cl) and R-CO-NR_{1c}-Y-Br(Cl).

These, by reacting with $AgNO_3$ in acetonitrile in accordance with known literature methods, lead to the final products A-X_1-NO_2.

The route may be outlined as follows:

$$\text{R-CO-Cl} + \text{NHR}_{1c}\text{-Y-OH} \xrightarrow{\quad} \text{R-CO-NR}_{1c}\text{-Y-OH} \xrightarrow{\ PCl_5\ } \text{R-CO-NR}_{1c}\text{-Y-Cl} + AgNO_3 \xrightarrow{\quad} \text{R-CO-NR}_{1c}\text{-Y-ONO}_2$$

wherein YO is X_{x1}.

An alternative route to form the esters is a reaction of the sodium or potassium salts of the acids with the nitric esters of halogen alcohols of the general formula:

NO_2-O-Y-Cl(Br,I)

to directly give the products of the invention.

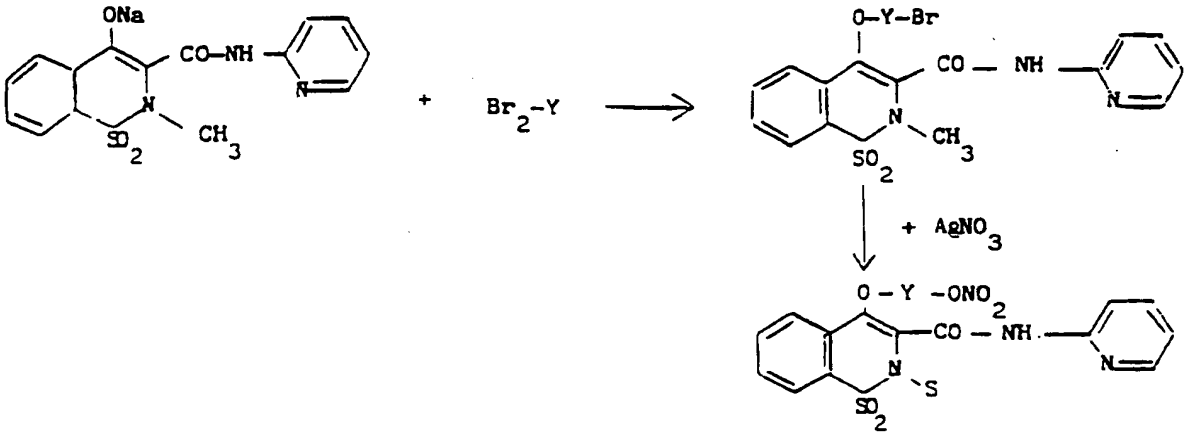
The reaction route is as follows:

$$R\text{-}CO\text{-}ONa + Br\text{-}Y\text{-}ONO_2 \longrightarrow R\text{-}CO\text{-}O\text{-}Y\text{-}ONO_2$$

wherein YO is X_1.

Synthetic routes similar to those described above can be used for products Va and Vb of group V), wherein the dihalogen derivative Br_2Y is reached with enolates, for example, of tenoxicam or piroxicam. The reaction products are then converted, in acetonitrile, by reacting with $AgNO_3$ in accordance with the above reaction.

The general route shown below relates to the piroxicam of formula IX in group V).



The above indicated products in the various groups are used as anti-inflammatory, analgesic, and anti-thrombotic

activities. For group I) no exclusion in the meanings of X_1 is necessary.

For groups II), III), IV) and V), the meaning of X_1 is limited as above indicated for these uses, when X_1 = -YO- for some compounds.

A further object of the invention is that it was surprisingly found that the products of the invention containing $-ONO_2$ groups are capable of having an effect inhibiting the inflammation induced by liposaccharide (LPS), and can, therefore, be used in septic shock.

This was surprising since it is well known that, generally, anti-inflammatories do not significantly change the nitrosynthetase actitivity induced by lipopolysaccharides in rats and, therefore, cannot be used in septic shock.

The products which may be used for this pharmaceutical use are the products of the general formula

$$A\text{-}X_1\text{-}NO_2$$

described above, wherein the bivalent connecting bridge X_1 has no limitation in this case, i.e. the known connecting bridges are not excluded as nothing was described in previous patents for this use.

It must be understood that when the compounds of the various groups contain at least one asymmetric carbon, the

products can be used in racemic form or as single isomers. It is in fact well known that in the therapeutic uses of the invention in general an isomeric form is more active than the others.

The following examples are being given as an explanation not a limitation of the present invention.

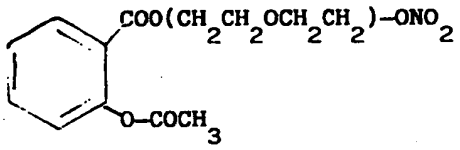
EXAMPLES

Example 1: Chemical Examples - Product Preparation

Example 1a:

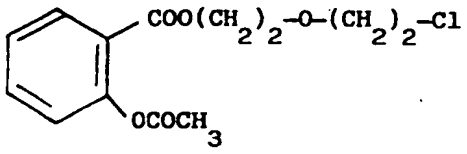
Preparation of compound $A\text{-}X_1\text{-}NO_2$, wherein R belongs to class I, X_1 is $-(CH_2\text{-}CH_2\text{-}O)_2-$, herein referred to as ASA.NO-DEG, and having the general formula:

2-acetoxy-benzoate of 2-[2-(nitroxy)ethoxy]ethyl



Preparation of the intermediate of the formula:

2-acetoxy-benzoate of 2-[2-(chloro)ethoxy]ethyl



1.0 g of sodium hydride (NaH) (80% suspension in white mineral oil) was added portionwise to a solution of:

acetylsalicylic acid 5.6 g and

dimethylformamide 20 ml

kept at 0°C in a stream of nitrogen.

The mixture was stirred for one hour and then added dropwise over 5 hours to a stirred solution of

2,2'-dibromo-diethylether 10.0 g and

dimethylformamide 15 ml

at 25°C. The mixture was stirred continuously for 3 days, then dried at reduced pressure. The residue was treated with:

water 50 ml and

dichloromethane 50 ml.

The phases were separated and the aqueous phase was extracted further with dichloromethane 10 ml.

The pooled organic phases were washed with water (3 x 25 ml), dried ($MgSO_4$), decoloured with animal charcoal (1 g), and brought to dryness in vacuum.

The residue (11.2 g) was used crude for the next reaction.

Preparation of ASA-NO-DEG:

8.6 g of silver nitrate were added to a solution of

ASA-$(CH_2)_2$-O-$(CH_2)_2$ Cl	11.2 g and
acetonitrile	25 ml

kept at ambient temperature and sheltered from light.

After stirring for two days, 2.2 g of silver nitrate were added.

After another two days in the same conditions, the insoluble salts were filtered and the filtrate was freed of the solvent at reduced pressure.

A residue of 7.0 g was obtained and chromatographed on a silica gel column (500 g of silica) eluting with a toluol/ethyl acetate 95/5 v/v mixture.

The fractions which were found to be uniform by TLC (Thin Layer Chromatography) were pooled and brought to dryness. They yielded 3.0 g of ASA-NO-DEG.

A ^1H NMR analysis ($CDCl_3$) (80MHz) provided the following data:

2.28(3H,s); 3.7(4H,m); 4.35(2H, t); 4.52(2H,t); 7.3 (3H,m); 7.98 (1H,dd).

The IR analysis (nujol) provided the following results.

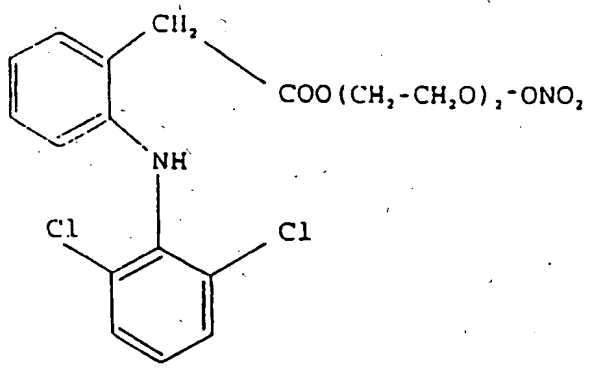
υ_{OCO} = 1780 cm^{-1}; υ_{COO} = 1725 cm^{-1}; υ_{ONO2} = 1641 e 1287 cm^{-1}.

Mass spectrometry gave a molecular weight value of 313.

Example 1b:

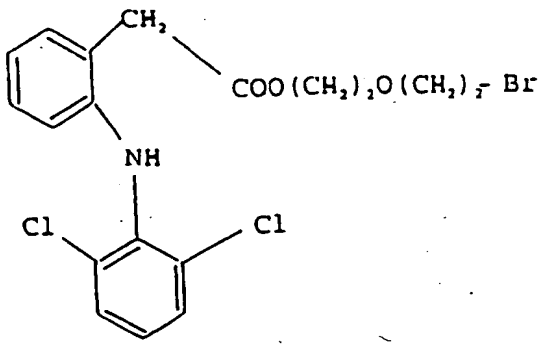
Preparation of compound $A-X_1-NO_2$, wherein R belongs to class II), X_1 is $-(CH_2-CH_2-O)_2-$, herein referred to as DICLOFENAC-NO-DEG, and having formula:

2-{N-[2,6-(dichloro)phenyl]amino}phenylacetate of 2-[2-(nitroxy)ethoxy]ethyl



Preparation of the intermediate having formula

2-{N-[2,6-(dichloro)phenyl]amino}phenylacetate of 2-[2-(bromo)ethoxy]ethyl



A solution of

DICLOFENAC sodium salt	13.3 g and
dimethylformamide	25 ml

was added to a solution of

2.2'-dibromo-diethylether	12.3 g and
dimethylformamide	15 ml

kept at ambient temperature in a stream of nitrogen.

The mixture was allowed to react for two days, and the solvent was then removed at reduced pressure. The residue was treated with ethyl acetate (50 ml), washed with a 5% solution of potassium carbonate (2 x 10 ml), then with water (20 ml), dried over anhydrous sodium sulphate. The solvent was removed at reduced pressure.

The residue weight was 16 g and was used for the next reaction with no purification.

Preparation of DICLOFENAC-NO-DEG:

Silver nitrate	8 g in
acetonitrile	16 ml

were added to a solution of

DICLOFENAC $-(CH_2)_2-O-(CH_2)_2-Br$	16 g and
acetonitrile	30 ml

kept at room temperature and sheltered from light.

The mixture was stirred at ambient temperature for 3 days.

Silver nitrate 3 g after 1 day

silver nitrate 3 g after 2 days

were then added.

The mixture was stirred for another 2 days. The insoluble salts were then filtered and the solvent removed from the filtrate at reduced pressure. The residue was treated with ethyl acetate (50 ml), the insoluble salts were then filtered and discarded. The solvent was removed from the filtrate at reduced pressure. A residue of 16.2 g was obtained and chromatographed on a silica gel column (700 g of silica) eluting first with toluol, then with a toluol/ethyl acetate 99/1 v/v mixture, finally with a toluol/ethyl acetate 98/2 v/v mixture.

The fractions found to be uniform by TLC analysis (thin layer chromatography) were pooled and brought to dryness to yield 4.38 g of DICLOFENAC-NO-DEG.

A ^{1}H-NMR analysis ($CDCl_3$) (300 MHz) provided the following data: 3.69 (4H,t); 3.87 (2H,s); 4.3 (2H,m); 4.52 (2H,t); 6.55 (1H,d); 6.88 (1H, wide s exchanged for D_2O, NH); 6.97 (2H,t); 7.11 (2H,d); 7.23 (2H,d); 7.35 (2H, d).

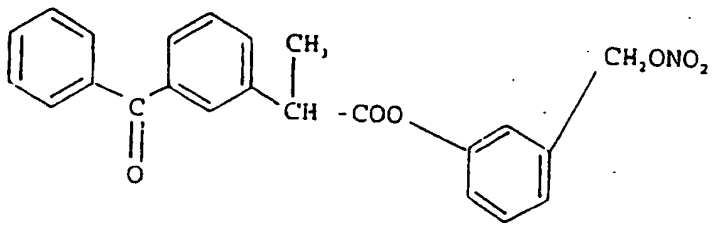
Mass spectrometry yielded a molecular weight value of 588.

Example 1c:

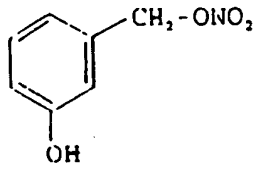
Preparation of compound A-X_1-NO_2, wherein R belongs to class

III) and represents the residue of the compound of formula IV, X_1 is $-C_6H_5CH_2-$, herein referred to as KETOPROFEN-NO-DEG, and having formula:

2-(3-benzoyl)phenylpropionate of 3-(nitroxymethyl)phenyl



Preparation of intermediate 3-nitroxymethyl-phenol having formula:



The reagents below are used in the amounts indicated and reacted as described below:

3-hydroxy-benzylalcohol	10	g
48% HBr by weight	50	ml
CH_2Cl_2	30	ml
$AgNO_3$	13.7	g

CH_3CN	70 ml

3-Hydroxy-benzylalcohol in CH_2Cl_2 was reacted with HBr at ambient temperature for 4 hours.

CH_2Cl_2 was then evaporated at reduced pressure at 30°C after washing with an aqueous 5% $NaHCO_3$ solution and drying over anhydrous Na_2SO_4.

The oily residue was dissolved in CH_3CN (50 ml) and a solution of $AgNO_3$ in the remaining amount of CH_3CN was added dropwise. The flask was sheltered from light.

After 8 hours the AgBr precipitate was filtered and the organic phase was evaporated at reduced pressure.

The oily residue so obtained was dissolved in toluene (45 ml) and the solution was filtered on a silica gel column (400 g). The eluate was brought to dryness at reduced pressure at 30°C to give 20 g of 3-nitroxymethylphenol.

Preparation of intermediate KETOPROFEN -COCl:

a chloride of 2-(3-benzoyl)phenyl propionic acid

KETOPROFEN	20 g
thionyl chloride	50 ml

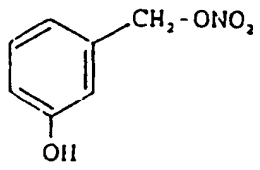
were reacted and the solution was refluxed for 45 minutes. Thionyl chloride was evaporated off at reduced pressure. An oily yellow residue weighing 21 g was obtained and used with no further purification.

Preparation of KETOPROFEN-Ar-NO_2

The reagents below were used in the following amounts:

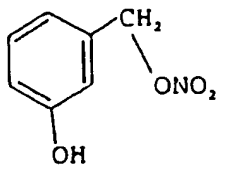
KETOPROFEN -COCl 5.45 g

3-nitroxymethylphenol 3.9 g



K_2CO_3 5.5 g

AcOEt 50 ml:

 , K_2CO_3 and AcOEt were added together;

ketoprofen chloride was then added under nitrogen at t = 0 in 30 minutes.

The whole was allowed to react for 5 hours at ambient temperature, then diluted with H_2O (50 ml). The organic phase was washed with 5% NaOH (2 x 10 ml) and evaporated off at reduced pressure. The resulting oily residue was chromatographed on silica using a toluol/EtOAc 9.5/0.5 v/v mi-

xture as an eluant. The evaporation of the eluate gave KETOPROFEN-Ar-NO_2 with a yield of 85%.

A ^{1}H-NMR analysis ($CDCl_3$) (300 MHz) provided the following data: 1.63 (3H,d); 4.00 (1H Q); 5.37 (2H,S); 7.01-7.89 (m,13H).

Mass spectrometry yielded a molecular weight value of 405.

Example 1d:

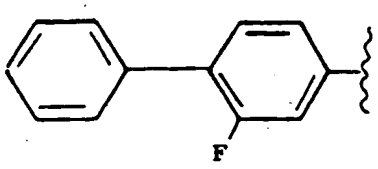
Preparation of compound A - X_1 - NO_2, herein referred to as IBUPROFEN-NO-DEG, wherein R belongs to group IV; X_1 is $-(CH_2-CH_2-O)_2-$, A = RCOO, R residue of IBUPROFEN, having formula:

$$-(CH_3)_2CHCH_2C_5H_4-CH(CH_3)-$$

The same procedure of example 1a was followed, using the above R, residue of IBUPROFEN, instead of residue R of group I as shown in example 1a.

Example 1e:

Preparation of compound A-X_1-NO_2, herein referred to as FLURBIPROFEN-NO-DEG, wherein R belongs to group III; X1 is $-(CH_2-CH_2-O)_2-$, A = RCOO, R_{3a} = H, R_{2a} = CH_3, R having formula:

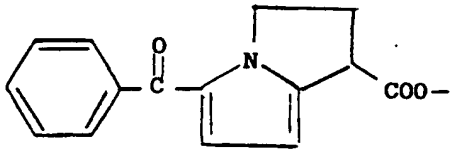


(IX)

The same procedure of example 1a was followed, using the above R, residue of FLURBIPROFEN, instead of residue R of group I as shown in example 1a.

Example 1f:

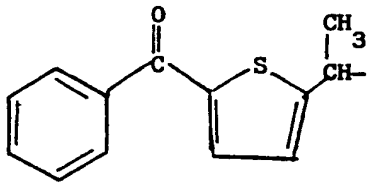
Preparation of compound A-X_1-NO_2, KETOROLAC-NO-DEG, wherein R belongs to group V; X_1 is -$(CH_2$-CH_2-$O)_2$-; A = R, R of formula II, having formula



The same procedure of example 1a was followed, using the above R, residue of KETOROLAC, instead of residue R of group I as shown in example 1a.

Example 1g:

Preparation of compound A-X_1-NO_2, TIAPROFENIC ACID NO DEG, wherein R belongs to group III; X_1 is -$(CH_2$-CH_2-$O)_2$-, A= RCOO, R is the residue of formula XXXV, wherein R is:

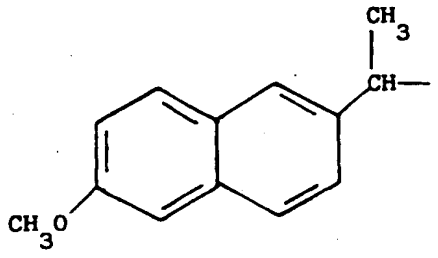


(XXXV)

The same procedure of example 1a was followed, using the above R, residue of TIAPROFENIC ACID, instead of residue R of group I as shown in example 1a.

Example 1h:

Preparation of compound A - X_1 - NO_2, NAPROXEN NO-DEG, wherein R belongs to group IV; X_1 is $-(CH_2-CH_2-O)_2-$, A = RCOO, R is the residue of formula II of NAPROXEN, having the general formula



(II)

The same procedure of example 1a was followed, using the above R, residue of NAPROXEN, instead of residue R of group I as shown in example 1a.

EXAMPLE 2: Pharmacological Examples

The products used above were pharmacologically characterised.

Example 2a: ASA-NO-DEG as prepared in example 1a;

Example 2b: DICLOFENAC-NO-DEG as prepared in example 1b;

Example 2c: KETOPROFEN-NO-DEG as prepared in example 1c;

Example 2d: IBUPROFEN-NO-DEG as prepared in example 1d;

Example 2e: FLURBIPROFEN-NO-DEG as prepared in example 1e;

Example 2f: KETOROLAC NO-DEG as prepared in example 1f;

Example 2g: TIAPROFENIC ACID NO-DEG as prepared in example 1g;

Example 2h: NAPROXEN NO-DEG as prepared in example 1h.

Toxicity

Acute toxicity was evaluated by orally administering a single dose of 1, 3, 10, 30, 100 mg/Kg of product groups of 10 mice.

The death rate and the occurence of toxic symptoms were reported over an observation period of 14 days. Even after administration of a 100 mg/Kg dose the animals showed no sign of apparent toxicity.

Anti-inflammatory activity

Anti-inflammatory activity was determined by the carrageenin-oedema method as described by Winter et al. (Proc. Soc. Exp. Biol. Med. 111, 544, 1962) in rats.

Analgesic activity

Analgesic activity was determined in Swiss mice as described by Hendershot et al. (J. Pharmacol. Exp. Therap.

125, 237, 1959).

Tolerance

Gastric tolerance was measured by oral administration to rats assessing the severity of the gastropathy induced in accordance with the criteria described by Wallace et al. (Am. J. Physiol. 259, G642, 1990).

Platelet anti-aggregating activity

Platelet anti-aggregating activity was evaluated in vitro on human platelets stimulated by thrombin in accordance with the method described by Bertele et al. (Science 220, 517. 1983).

Vasodilative activity

Vasodilative activity was determined in isolated rat aorta measuring the inhibition of the contraction induced by epinephrine in the tissue prepared in accordance with the method described by Reynolds et al. (J. Pharmacol. Exp. Therap. 252, 915, 1990).

COX Inhibition

The activity inhibiting cyclo-oxygenase was determined in isolated cells. Endothelial cells of bovine aorta were used as a source of COX-1 and macrophage line J774.2 as a source of COX-2. The same conditions described byMitchell et al. (Proc. Nat. Acad. Sci. 90, 11693, 1993) for growth and

the viability test were used.

In brief, the cells were incubated for 30 minutes with scalar concentrations of the test product and the substrate (arachidonic acid) was then added and incubated for another 15 minutes. Enzyme activity was determined radioimmunologically by measuring the formation of 6-keto-PGF 1 alpha. In the case of cell lines J.774.2, the cells were incubated for 12 hours with endotoxin to promote COX-2 formation.

Nitrosynthetase inhibition by LSP

The nitrosynthetase inhibition activity induced by lipopolysaccharide (LPS) was determined in rat neutrophils and stomach after administration of one of the test compounds and compared with that obtained after treatment of the suspension vehicle only.

In brief, Wistar rats fasting for 24 hours before treatment were orally administered the test product (10 mg/Kg) and intravenously (caudal vein) administered LPS (5 mg/Kg).

Four hours later the animals were sacrificed and the blood - for neutrophils isolation - and the stomach taken.

Enzyme activity was determined in accordance with the method described by Assreuy et al. (Br. J. Pharmacol. 108, 833, 1993).

Results:

The results obtained are described below.

As it may be observed from the data shown in tables 1 to 4, the pharmacodynamic activities (I and II in Table 1; Table 2) and the tolerance (Table 1 column III) of the nitroderivatives show a better balance as compared to natural products.

Table 4 also shows that, similarly to diclofenac nitroxybutylester, the diclofenac nitroderivative which is an object of this patent is capable of directly inhibiting cyclo-oxygenase COX-1 and COX-2, but with a significantly lower variability.

TABLE 1 (Pharmacology col.I and II; Toxicology col.III)

Study of the anti-inflammatory (I) and analgesic (II) properties (pharmacodynamics) and gastrointestinal tolerance (III) (toxicity) of the test compounds after oral administration of doses ranging from 3 to 30 mg/Kg in carboxymethylcellulose suspensions and constructing dose-response curves. The results shown are the potency ratio as compared to the reference standard.

Activities are expressed as the potency ratio compared to the natural product used as a unit standard. The nitroderivative is that of the shown examples, the natural

reference compound is that shown as a reference.

TABLE 1

TEST COMPOUND	EXAMPLE	I	II	III
NITRODERIVATIVE ASPIRIN	1a reference	1.2 1.0	1.1 1.0	0.2 1.0
NITRODERIVATIVE DICLOFENAC	1b reference	1.3 1.0	0.9 1.0	0.3 1.0
NITRODERIVATIVE KETOPROFEN	1c reference	1.0 1.0	1.2 1.0	0.1 1.0
NITRODERIVATIVE IBUPROFEN	1d reference	1.0 1.0	1.1 1.0	0.1 1.0
NITRODERIVATIVE FLURBIPROFEN	1e reference	1.0 1.0	1.0 1.0	0.1 1.0
NITRODERIVATIVE KETOROLAC	1f reference	1.0 1.0	1.0 1.0	0.1 1.0
NITRODERIVATIVE TIAPROFENIC ACID	1g reference	0.9 1.0	1.3 1.0	0.1 1.0
NITRODERIVATIVE NAPROXEN	1h reference	1.3 1.0	1.3 1.0	0.1 1.0

TABLE 2 (Pharmacodynamic activity)

Example of the anti-cyclooxygenase (I), platelet anti-aggregating (II) and vasodilative (III) properties of the test compounds tested in vitro at concentrations in the molar range from 10^{-5} to 10^{-7} of the product in water/alcohol with the addition of small amounts of DMSO (dimethylsulphoxide). The activities are expressed as the potency ratio versus the natural product used as a unit standard, as stated in Table 1.

TABLE 2

TEST COMPOUND	EXAMPLE	I	II	III(°)
NITRODERIVATIVE ASPIRIN	1a reference	1.5 1.0	3.0 1.0	60 inactive
NITRODERIVATIVE DICLOFENAC	1b reference	1.8 1.0	1.8 1.0	50 inactive
NITRODERIVATIVE KETOPROFEN	1c reference	1.2 1.0	1.8 1.0	50 inactive

(°) % of inhibitory action of the vasospasm induced by epinephrine

TABLE 3 (Biochemistry: Action on NOS for Septic Shock)

Study of the inhibitory properties of the nitrosynthetase (NOS) activity induced by liposaccharide (LPS) in rats using oral doses ranging from 5 to 20 mg/Kg suspended in a carboxymethylcellulose base.

TABLE 3

NOS (°°)

TREATMENT	EXAMPLE	STOMACH	NEUTRO-PHILS
LPS	reference	100	100
LPS+NITRODERIVATIVE KETOPROFEN of Ex.	1c	40	30
LPS + NITROXYBUTYLKETOPRO-FEN	reference	35	55
LPS+NITRODERIVATIVE DICLOFENAC of ex.	1b	40	52
LPS+NITROXYBUTYLDI-CLOFENAC	reference	37	49

(°°) inhibition % relative to the group treated with LPS only.

TABLE 4 (COX-Inhibition Activity)

Study of the anti-cyclooxygenase (COX-1/COX-2) properties in isolated cells.

Response expressed as a % of the controls with relative response variability.

TABLE 4

COMPOUND	EXAMPLE	DOSE mg/ml (solution of Table 2)	COX-1	COX-2
NITRODERIVATIVE DICLOFENAC	1b	0.1 1.0	49+/-6 29+/-4	45+/-3 22+/-4
DICLOFENAC NITROXYBUTYLESTER	reference	0.1 1.0	45+/-22 24+/-10	68+/-11 41+/-11
NITRODERIVATIVE FLURBIPROFEN	1e	0.1 1.0	51+/-5 22+/-3	47+/-4 18+/-2
FLURBIPROFEN NITROXYBUTYLESTER	reference	0.1 1.0	48+/-18 29+/-13	46+/-23 22+/-14

CLAIMS

1. Compounds, or their compositions, of the general formula:

$$A - X_1 - NO_2$$

or their salts, wherein:

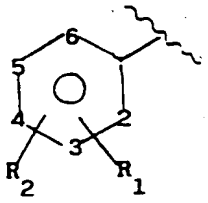
A = $R(COX_u)_t$, wherein t is zero or 1; u is zero or 1,

X = O, NH, NR_{1c} wherein R_{1c} is a linear or branched alkyl having 1 to 10 C atoms;

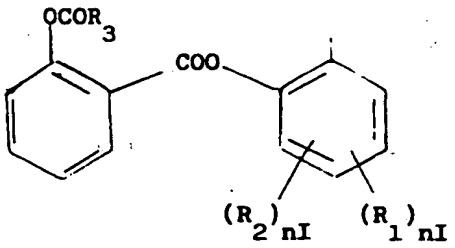
R is chosen from the following groups:

- group I), wherein t = 1 and u = 1

Ia)

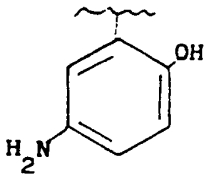


Ib)

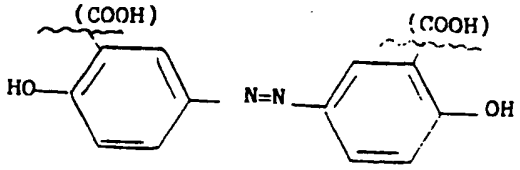


60

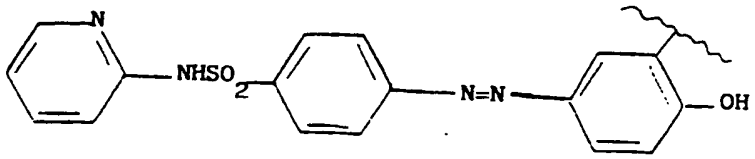
Ic)



Ic_1)



Ic_2)



Ic_3)

wherein:

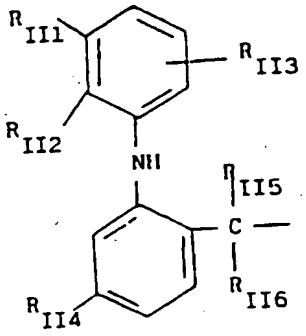
R_1 is an $OCOR_3$ group, wherein R_3 is methyl, ethyl or a linear or branched C_3-C_5 alkyl, or the residue of a heterocycle with a single ring having 5 or 6 atoms which may be aromatic, partially or totally hydrogenated, containing one or more heteroatoms independently chosen from O, N, and S;

R_2 is hydrogen, hydroxy, halogen, a linear or when permissible branched alkyl having 1 to 4 C atoms, a linear or when permissible branched alkoxyl having 1 to 4 C atoms, a linear or when permissible branched perfluoroalkyl having 1 to 4 C atoms, for example trifluoromethyl, nitro, amino, mono- or di-(C_{1-4})alkylamino;

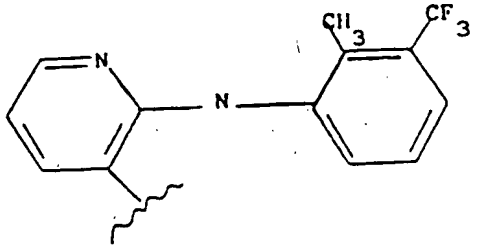
R_1 and R_2 together are a dioxymethylene group, with the

proviso that when X = NH, X_1 is ethylene and R_2 = H; R_1 cannot be $OCOR_3$ in position 2 when R_3 is methyl; nI being 0 or 1;

- group II) wherein t = 1 and u = 1



IIa)



IIb)

wherein:

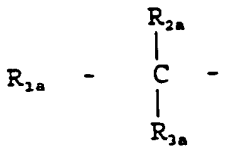
R_{II5} is H, a linear or when permissible branched C_1-C_3 alkyl, R_{II6} has the same meaning as R_{II5}, or, when R_{II5} is H, it may be benzyl;

R_{II1}, R_{II2} and R_{III3}, independently from one anotner, are hydrogen, a linear or when permissible branched C_1-C_6

alkyl or C_1-C_6 alkoxy, or Cl, F, Br;

R_{III4} is R_{III1} or bromine;

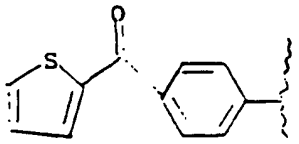
- group III), wherein t = 1, u = 1 and R is:



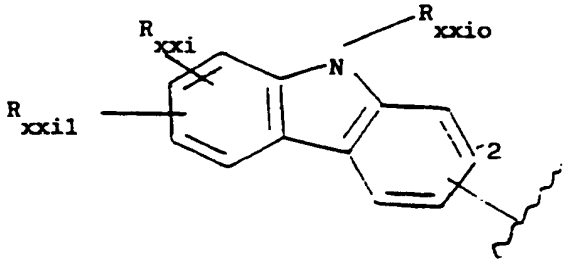
wherein:

R_{2a} and R_{3a} are H, a linear or when permissible branched, substituted or nonsubstituted C_1-C_{12} alkyl, allyl, with the proviso that when one of the two groups is allyl, the other is H; preferably R_{2a} is H, an alkyl having from 1 to 4 C, R_{3a} is H;

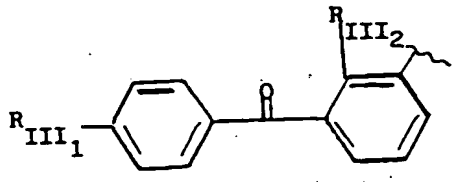
R_{1a} is chosen from



(II)



(XXI)



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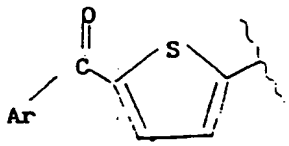
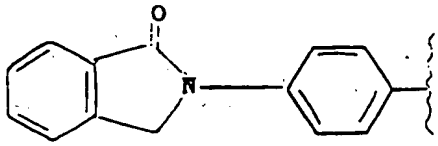
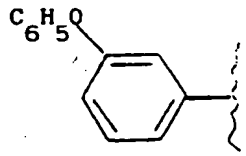


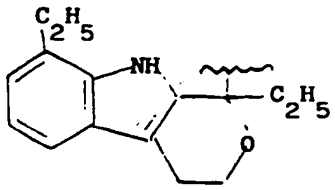
(XXXV)



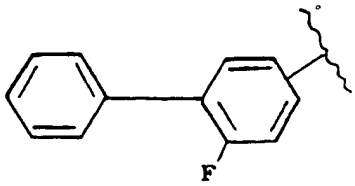
(VI)



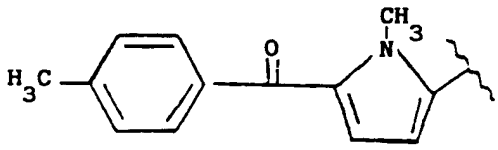
(VII)



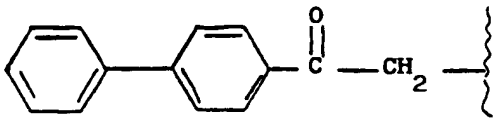
(VIII)



(IX)

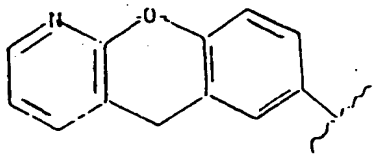


(X)

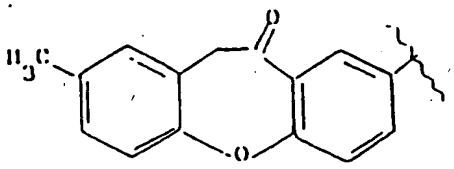


(III)

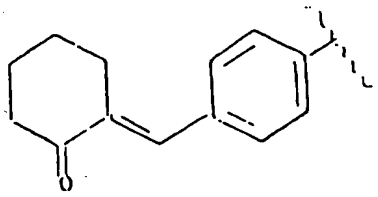
III D) has the following compounds:



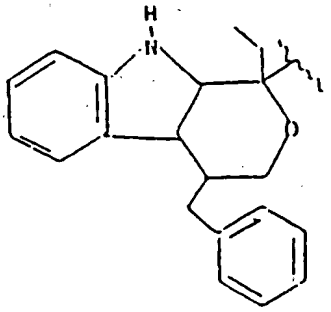
IIa)



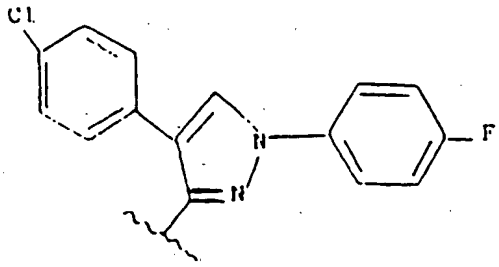
(XXX)



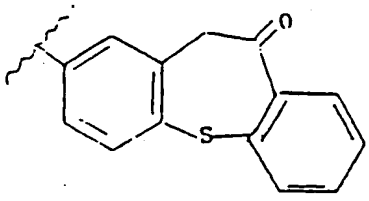
(XXXI)



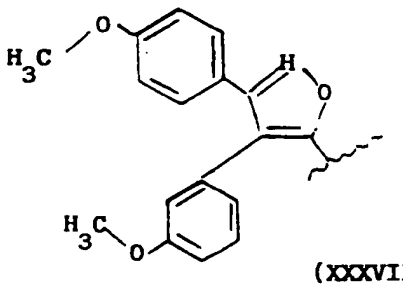
(XXXII)



(XXXIII)



(XXXVI)



(XXXVII)

wherein the meanings are as follows:

- in the compound of formula (IV), residue of Ketoprofen:

  R_{III1} is H or SR_{III3} wherein R_{III3} contains from 1 to 4 C atoms, linear or when permissible branched;

  R_{III2} is H, hydroxy;

  preferred are the compounds wherein R_{III1} and R_{III2} are H, R_{3a} is H and R_{2a} is methyl, X = 0;

- in the compounds of formula (XXI), residue of carprofen:

  R_{XXio} is H, a linear or when permissible branched alkyl having from 1 to 6 C atoms, a C_1-C_6 alkoxycarbonyl bound to a C_1-C_6 alkyl, a C_1-C_6carboxylalkyl, a C_1-C_6 alkanoyl, optionally substituted with halogens, benzyl or halobenzyl, benzoyl or halobenzoyl;

  R_{XXi} is H, halogen, hydroxy, CN, a C_1-C_6 alkyl optionally containing OH groups, a C_1-C_6 alkoxy, acetyl, benzyloxy, SR_{XXi2} wherein R_{XXi2} is an alkyl C_1-C_6; a perfluoroalkyl

having from 1 to 3 C atoms, a C_1-C_6 carboxyalkyl optionally containing OH groups, NO_2, ammino, sulphamoyl, a dialkyl sulphamoyl with the alkyl having from 1 to 6 C atoms, or a difluoroalkylsulphonyl with the alkyl having from 1 to 3 C atoms;

R_{XXii} is halogen, CN, a C_1-C_6 alkyl containing one or more OH groups, a C_1-C_6 alkoxy, acetyl, acetamide, benzyloxy, SR_{III3} as above defined, a perfluoroalkyl having from 1 to 3 C, hydroxy, a carboxyalkyl having from 1 to 6 C, NO_2, ammino, a mono- or di-alkylamino having from 1 to 6 C, sulphamoyl, a di-alkyl sulphamoyl having from 1 to 6 C, or a difluoroalkylsulphamoyl as above defined; or R_{XXi} together with R_{XXii} is an alkylene dioxy having from 1 to 6 C;

preferred are the compounds wherein R_{XXio} is H, the connecting bridge is in position 2, R_{XXi} is H, R_{XXii} is chlorine and is in the para position relative to nitrogen;

R_{3a} is H, R_{2a} is methyl and X is O;

in the compounds of formula (XXXV), residue of tiaprofenic acid:

Ar is phenyl, a hydroxyphenyl optionally mono- or polysubstituted with halogen, an alkanoyl and an alkoxy having from 1 to 6 C, a trialalkyl having from 1 to 6

C, preferably from 1 to 3 C, cyclo-pentyl, cylo-hexyl, cyclo-heptyl, heteroaryl, preferably thienyl, a furyl optionally containing OH, pyridyl;

the preferred (XXXV) compounds are those wherein Ar is phenyl, R_{3a} is H, R_{2a} is methyl and X is O;

- in the compound of formula (II), residue of suprofen, wherein R_{3a} is H, R_{2a} is methyl and X = O, or its equivalents;
- in the compound of formula (VI), residue of indoprofen, wherein R_{2a} is CH_3, and residue of indobufen wherein R_{2a} is H, R_{3a} = $-CH_3$, and X = O and its equivalents;
- in the compounds of formula (VIII), residue of etodolac, wherein R_{2a} = R_{3a} = H and X = O and its equivalents;
- in the compounds of formula (VII), residue of fenoprofen, wherein R_{3a} = X, R_{2a} = $-CH_3$ and X = O and its equivalents;
- in the compounds of formula (III), residue of fenbufen, wherein R_{2a} = R_{3a} = H and X = O and its equivalents;
- in the compounds of formula (IX), residue of flurbiprofen, wherein R_{3a} is H, R_{2a} is $-CH_3$ and X = O;
- in the compounds of formula (X), residue of tolmetin,

wherein R_{2a} = R_{3a} = H and X = 0 or its equivalents;

- compound IIIa), when it contains the -CH(CH_3)-COOH, is pranoprofen residue: α-methyl-5H-[1]benzopyrano [2,3b]-pyridine-7-acetic acid;

the preferred compound has R_{2a} = H, R_{3a} = -CH_3, u = 1 and X = O;

- compound (XXX), when it contains -CH(CH_3)-COOH is bermoprofen residue: dibenz[b,f]oxepin-2-acetic acid;

the preferred compound has u = 1, X = O, R_{2a} = H, R_{3a} = CH_3;

- compound (XXXI) is CS-670 residue: 2-[4-(2-oxo-1-cyclohexylidenemethyl)phenyl]propionic acid, when the radical is -CH(CH_3)-COOH; the preferred compound has R_{2a} = H, R_{3a} = CH_3, u = 1, X = O;

- compound (XXXII) derives from the pemedolac which contains the -CH_2COOH groups; the preferred compound has R_{2a} = R_{3a} = H, u = 1 and X = O;

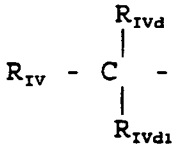
- compound (XXXIII) is pirazolac residue when is saturated with -CH_2COOH: 4-(4-chlorphenyl)-1-(4-fluorphenyl)3-pyrazolyl acid derivatives; the preferred compounds have R_{2a} = R_{3a} = H, u = 1 and X = O;

- compound (XXXVI) when saturated with -CH(CH_3)-COO-, is zaltoprofen residue, when saturated with an hydroxy or

an amino group or the salts of the acid is one of the dibenzothiepin derivatives; the preferred products have a R_{2a} = H, R_{3a} = CH_3, u = 1, X = O;

compound (XXXVII) is deriving from the mofezolac: 3,4-di(p-methoxyphenyl)isoxazol-5-acetic acid, when the residue is $-CH_2-COOH$; the preferred compounds are R_{2a} = R_{3a} = H, t = 1, X = O;

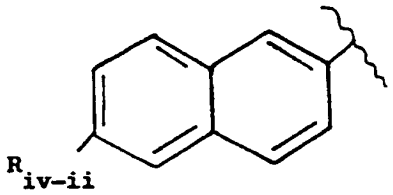
group IV) in which t = 1, u = 1 and R is



wherein:

R_{IVd} and R_{IVd1} are at least one H and the other a linear or when permissible branched C_1-C_6 alkyl, preferably C_1 and C_2, or a difluoroalkyl with the alkyl having from 1 to 6 C, C_1 is preferred, or R_{IVd} and R_{IVd1} together form a methylene group;

R_{IV} has the following meaning:



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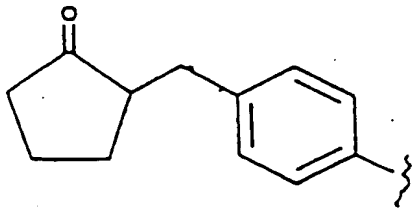
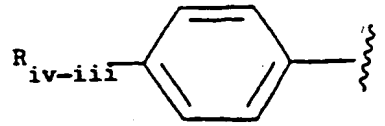


(X)



(III)

wherein the compounds of group IV) have the following meanings:

- in the compounds of formula (II):

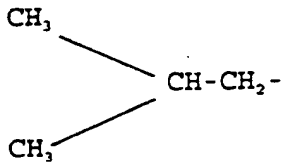
R_{iv-ii} is a 1-6 C alkyl, a cycloalkyl having from 3 to 7 C, an alkoxymethyl having from 1 to 7 C, a trifluoroalkyl having from 1 to 3 C, vinyl, ethinyl, halogen, an alkoxy having from 1 to 6 C, a difluoroalkoxy with the alkyl having from 1 to 7 C, an alkoxymethyloxy having from 1 to 7 C, an alkylthiomethyloxy with the alkyl having from 1 to 7 C, an alkyl methylthio with the alkyl having from 1 to 7 C, cyano, difluoromethylthio, phenyl-or phenylalkyl substituted with the alkyl having from 1 to 8 C; preferably R_{iv-ii} is $-CH_3O$, R_{IVd} is H and R_{IVd1} is $-CH_3$, which is a residue of naproxen;

X = NH or O and X_1 is equal to $-(CH_2-CH_2-O)_2$;

- in the compounds of formula (X), the residue of loxoprofen or its equivalents; preferred are the compounds in which R_{IVd} is H and R_{IVd1} is $-CH_3$, X = NH or O and X_1 is equal to $(CH_2-CH_2-O)_2$;

- in the compounds of formula (III): R_{iv-iii} is a C_2-C_5 alkyl, even branched whenever possible, a C_2 and C_3 alkyloxy, allyloxy, phenoxy, phenylthio, a cycloalkyl having from 5 to 7 C atoms, optionally substituted in position 1 by a C_1-C_2 alkyl;

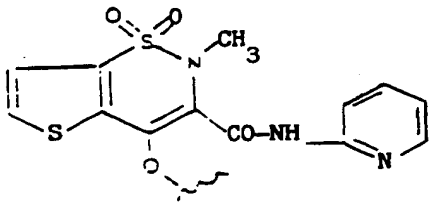
  preferred is the compound wherein R_{iv-iii} is



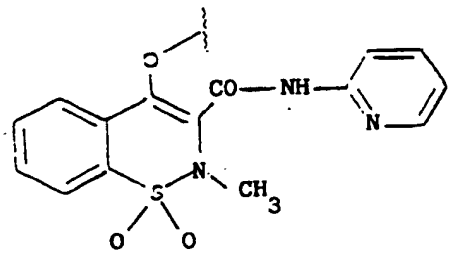
  and R_{IVd} = H, R_{IVd1} is $-CH_3$, which is a residue of ibuprofen;

  X = NH or O and X_1 is equal to $(CH_2-CH_2-O)_2$;

- group V)



(VII)



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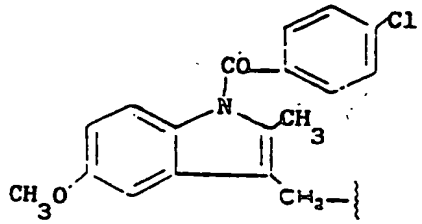

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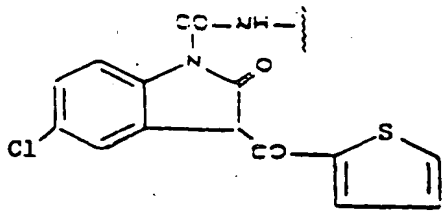

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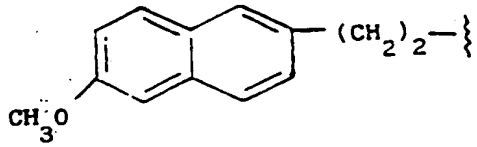
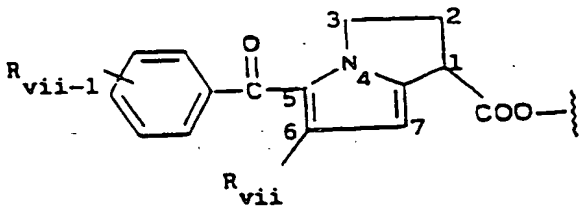
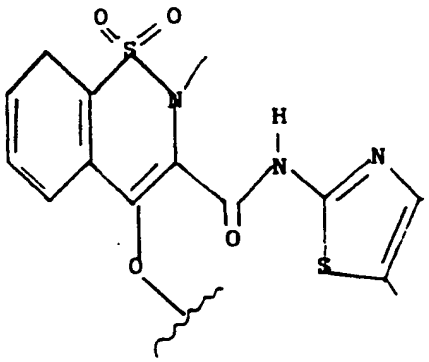


(III)

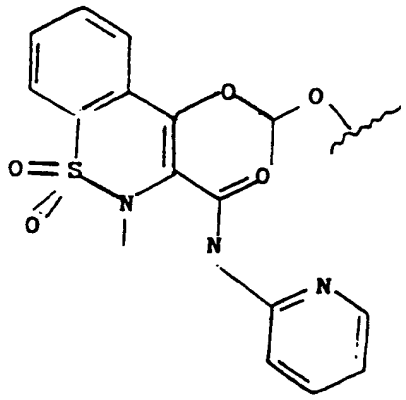


(II)

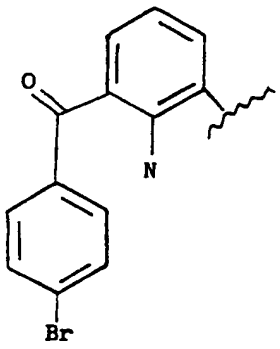
Class VE)



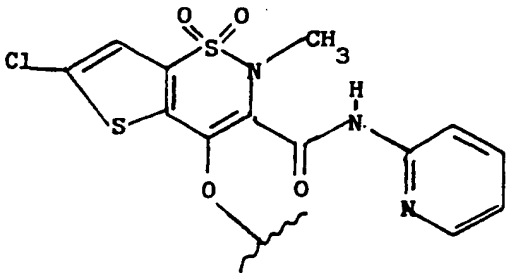
(X)



(XI)



(XII)



(XIII)

in group V), the compounds have the following meanings:

- in the compounds of formula (II), R_{vii} is H or a linear or when permissible branched alkyl having from 1 to 4 C; R_{vii-1} is R_{vii} or a linear or when permissible branched alkoxy having from 1 to 4 C; Cl, F, Br; the position of R_{vii-1} being o-, m- or p-; preferred is the residue of Ketorolac, wherein R_{vii} and R_{vii-1} are H, and A = R and t = 0
- in the compounds of formula (V), wherein A = R and t = 0, the residue of tenidap or its equivalents;
- in the compounds of formula (VII), wherein A is RCO and t = 1 and u = 0 or A is R and t = 0; the residue of tenoxicam or its equivalents;
- in the compounds of formula (IX) where A = R and t = 0, or A = RCO with t = 1 and u = 0, the residue of piroxicam or its equivalents;
- in the compounds of formula (III) where A = RCOO, t = 1 and u = 0 or 1; or t = 0 and A = R the residue of nabumetone or its equivalents;
- in the compounds of formula (IV) where A = RCOO, t = 1, u = 1 or the residue of indomethacin or its equivalents;
- In compounds of formula (X) the residue of meloxicam,

the preferred compounds are those in which t = 0;

- the residue (XI) ampiroxicam when the termination is $-COOC_2H_5$; the preferred compounds have u = 1 and X = O; or t = 0;
- the residue (XII) when saturated with $-CH_2COO-$ is bromfenac; the preferred compounds have u = 1, X = O and $R_{2a} = R_3a = H$; or t = 0;
- the residue XIII) derives from Lornoxicam when the valence is saturated with H, the preferred compounds have t = 0;

X_1 in the formula $A-X_1-NO_2$ is a bivalent connecting bridge chosen from the following:

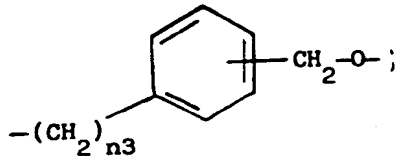
- -YO-

where Y is:

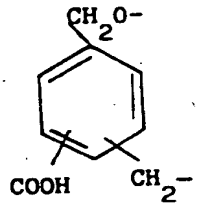
- a linear or when permissible branched C_1-C_{20} alkylene, preferably having from 2 to 5 carbon atoms, excluding this connecting bridge when R is:
  - a radical of group I) except classes Ib and Ic;
  - a radical of group II) excpet II_b);
  - a radical of group III) except class compounds of IIID);
  - a radical of group IV);
  - a radical of group V), except X) and inclu-

ding $-(CH_2)_4-$ for the compounds of formulae (III) and (IV);

- or a cycloalkylene having from 5 to 7 carbon atoms optionally substituted;

- 

wherein n_3 is 0 or an integer from 1 to 3

- 

- $-(CH_2-CH(ONO_2)-CH_2-O)_{nf'}$

wherein nf' is an integer from 1 to 6, preferably from 2 to 4;

- $-(CH(R_{1f})-CH_2-O)_{nf}$

wherein R_{1f} = H, $-CH_3$ and nf is an integer from 1 to 6, preferably from 2 to 4.

2. The compounds or their compositions according to claim 1, wherein, in group I):

in the compounds of formula Ia):

X is O, R1 is acetoxy, preferably in ortho-position with respect to -CO-, X_1 is $(CH_2-CH_2-O)_2$, R_2 is hydrogen; in Ib): $R_3 = CH_3$, nI = 0, X is equal to O, X_1 is ethylene; in this case Ib) is the residue of acetylsalicylsalicylic acid;

in group II: where R_{II1}, R_{II2} and R_{II4} are H, R_{II3} is chlorine and R_{II3} is in the ortho position relative to NH; R_{II5} and R_{II6} are H; X is equal to O, and X_1 is $(CH_2-CH_2-O)_2$.

3. The compounds or their compositions according to claim 1 or 2, for use as a medicament.

4. Use of the compounds or their compositions having general formula:

$$A-X_1-NO_2$$

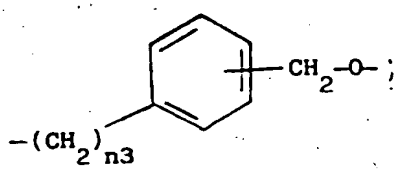
for the treatment of septic shock, wherein A has the meanings reported in claim 1 or 2 and X_1 is a bivalent connecting bridge chosen from the following:

-YO-

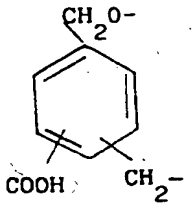
where Y is:

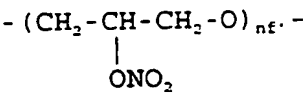
- a linear or when permissible branched C_1C_{20} alkylene, preferably having from 2 to 5 carbon atoms,
- a cycloalkylene having from 5 to 7 carbon atoms

optionally substituted;

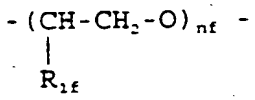


wherein n_3 is 0 or an integer from 1 to 3



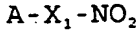


wherein nf' is an integer from 1 to 6, preferably from 2 to 4;



wherein R_{1f} = H, $-CH_3$ and nf is an integer from 1 to 6, preferably from 2 to 4.

5. Use of the compounds or their compositions having general formula:

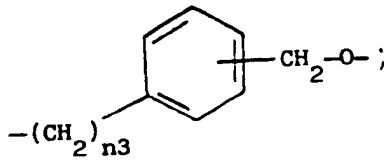


as antiinflammatory, wherein A has the meanings reported in claim 1 or 2 and X_1 is a bivalent connecting bridge chosen from the following:

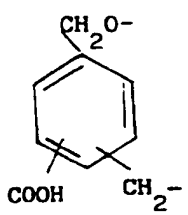
-YO-

where Y is:

- a linear or when permissible branched C_1-C_{20} alkylene, preferably having from 2 to 5 carbon atoms, excluding this connecting bridge when R is:
  - a radical of group II) except II_b);
  - a radical of group III) except class of compounds of IIID)
  - a radical of group IV);
  - a radical of group V), execpt X) and including $-(CH_2)_4-$ for the compounds of formulae (III) and (IV);
- a cycloalkylene having from 5 to 7 carbon atoms optionally substituted;



wherein n_3 is 0 or an integer from 1 to 3



- $-(CH_2-\underset{\underset{ONO_2}{|}}{CH}-CH_2-O)_{nf'}-$

  wherein nf' is an integer from 1 to 6, preferably from 2 to 4

- $-(\underset{\underset{R_{1f}}{|}}{CH}-CH_2-O)_{nf}-$

  wherein R_{1f} = H, $-CH_3$ and nf is an integer from 1 to 6, preferably from 2 to 4.

6. Use of the compounds or their compositions having general formula

$$A-X_1-NO_2$$

as anti-thrombotic wherein A has the meaning reported in claim 1 or 2 and X_1 is a bivalent connecting bridge chosen from the following:

-YO-

where Y is:

- a linear or when permissible branched C_1-C_{20} alkylene, preferably having from 2 to 5 carbon atoms, excluding this connecting bridge when R is:
  - a radical of group II) except II_b);
  - a radical of group III) except class of compounds of IIID)

. a radical of group IV);

. a radical of group V), except X) and including $-(CH_2)_4-$ for the compounds of formulae (III) and (IV);

- a cycloalkylene having from 5 to 7 carbon atoms optionally substituted;

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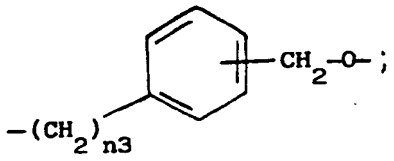

wherein n_3 is 0 or an integer from 1 to 3

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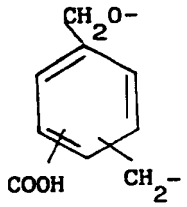


- $-(CH_2-CH(ONO_2)-CH_2-O)_{nf'}-$

wherein nf' is an integer from 1 to 6, preferably from 2 to 4

- $-(CH(R_{1f})-CH_2-O)_{nf}-$

wherein R_{1f} = H, $-CH_3$ and nf is an integer from 1 to 6, preferably from 2 to 4.

7. Use of the compounds or their compositions of the general formula:

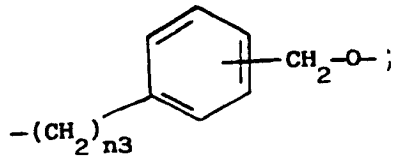
$$A\text{-}X_1\text{-}NO_2$$

as analgesic wherein A has the meanings reported in claim 1 or 2 and X_1 is a bivalent connecting bridge chosen from the following:

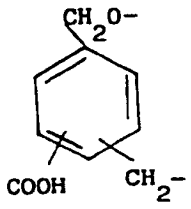
-YO-

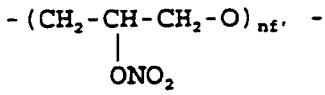
where Y is:

- a linear or when permissible branched C_1-C_{20} alkylene, preferably having from 2 to 5 carbon atoms, excluding this connecting bridge when R is:
  - a radical of group II) except II_b);
  - a radical of group III) except class of compounds of IIID)
  - a radical of group IV);
  - a radical of group V), except X) and including $-(CH_2)_4-$ for the compounds of formulae (III) and (IV);
- a cycloalkylene having from 5 to 7 carbon atoms optionally substituted;

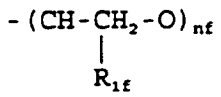


wherein n_3 is 0 or an integer from 1 to 3





wherein nf' is an integer from 1 to 6, preferably from 2 to 4



wherein R_{1f} = H, $-CH_3$ and nf is an integer from 1 to 6, preferably from 2 to 4.